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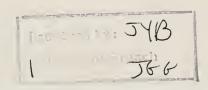
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# Forest Health Monitoring
## New England

*1990*

## Acknowledgments

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### 1990

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## New England Forest Resource

The six-state New England region is estimated to be over 80 percent forested. With a total land area of more than 40 million acres, forestland comprises over 32 million acres. The predominance of forestland occurs throughout New England, with Maine most extensively forested (89 percent) and forestland in southern New England exceeding 60 percent of total land area.

Over 85 percent of New England forests are classified as one of four major forest-type groups: White Pine, Spruce-Fir, Oak-Hickory, and Northern Hardwoods. Across New England, 76 tree species have been recorded on forest survey plots. The most common conifers are balsam fir and red spruce and the most common hardwood species is red maple.

The New England forest is maturing, with 46 percent presently classified as sawtimber-sized stands (trees generally larger than 10 or 11 inches in diameter) and presumably containing the oldest trees. The area of sawtimber-sized stands increased 36 percent from the surveys of the 1970's. Concurrently, smaller poletimber-sized stands (trees 5 to 10 or 11 inches in diameter) and seedling-sapling-sized stands (trees less than 5 inches in diameter) decreased, respectively, 8 and 51 percent in area.

The forests of New England have been, and continue to be, exposed to a broad range of stressors, both natural and human-caused. Natural stressors include weather extremes, forest insects, and pathogens. Human-caused stressors include land-use change, air pollution (for example, ozone), and acidic deposition. A new but unsubstantiated concern is global climate change due to generation of gases that create a "greenhouse effect."

The predominance of forests in New England, their importance for recreation, water, and wood products, and the increased awareness of stress upon forest ecosystems have resulted in a demand to address concerns about forest "health" and human influences.

## Forest Health Monitoring: New England

The public's concern for the "health and productivity of forests in certain regions of the United States" resulted in federal legislation mandating "such surveys as are necessary to monitor long-term trends in the health and productivity of domestic forest ecosystems" (Public Law 100-521). This mandate was implemented in the six New England states in 1990 with the cooperative efforts of the U.S. Department of Agriculture Forest Service (USDA Forest Service), U.S. Environmental Protection Agency (USEPA), and the six New England state foresters. Subsequent legislation (Public Law 101-624) encouraged the USDA Forest Service to work in partnership with state foresters or equivalent state officials to "monitor forest health."

Forest Health Monitoring (FHM) is intended to be a long term effort with a major emphasis to detect unexpected changes from established baseline forest conditions. Specific objectives of FHM are to: 1) characterize forest conditions, 2) characterize the major potential forest stressors, 3) quantify changes in forest conditions, and 4) analyze the relationships between changes in forest conditions and potential forest stressors.

Forest conditions will be described by the measurement and reporting of data from several "health" indicators. Five indicator groups have been selected: growth, foliar symptoms, soil chemistry, foliar chemistry, and landscape characterization. Individual measurements may support one or more indicators. Measurements will be made and indicators characterized on a periodic basis; annually for those that change frequently (for example, foliar symptoms) and on a 4 year or greater cycle for those that change less frequently (for example, soil chemistry).

FHM is based on the annual remeasurement of an extensive network of permanent locations, selected to correspond to a systematic sampling grid developed by the USEPA for their Environmental Monitoring and Assessment Program. In New England, this sampling design yields 263 sample locations on all lands, forest and nonforest.

Each location consists of a cluster of four plots. All trees, including seedlings and saplings, are located, marked, and measured. On, or adjacent to the FHM location, openings in the forest are searched for indicator plant species known to be sensitive to ozone, sulfur dioxide, and hydrogen fluoride. At each location, data are collected on the geographic and topographic position and physiographic description of the location; tree species, diameter, crown position, crown condition, and damage; other vegetation; and foliar symptoms on indicator plants. Data quality standards are specified in the field data collection manual and explained during field crew training. These standards were monitored by the remeasurement of a subset of locations and trees.

# 1990 Results

## Sample Distribution

The 263 FHM locations in New England represent the forest resource as reported by the most recent forest surveys. The distribution of the forested plots does not differ significantly from that expected of previous forest surveys for land use, forest-type group, or stand-size class.

**Number of New England Forest Health Monitoring Locations, by Major Forest-type Group and State or Region**

| Forest-type Group | Maine | New Hampshire | Vermont | Southern New England[1] | Total New England |
|---|---|---|---|---|---|
| E. White Pine | 18 | 7 | 4 | 5 | 34 |
| Spruce-Fir | 48 | 1 | 7 | 0 | 56 |
| Oak-Hickory | 2 | 2 | 0 | 14 | 18 |
| Northern hardwoods | 37 | 19 | 10 | 5 | 71 |
| Other groups | 13 | 4 | 3 | 7 | 27 |
| **All groups** | **118** | **33** | **24** | **31** | **206** |
| Nonforest | 19 | 4 | 11 | 23 | 57 |
| **All plots** | **137** | **37** | **35** | **54** | **263** |

[1]Connecticut, Massachusetts, and Rhode Island.

A total of 63 species, 14 conifers and 49 hardwoods, were tallied. This is less than the 76 species, 16 conifers and 60 hardwoods, tallied on the extensive forest survey plots. While the distribution of trees by species is not significantly different from that expected, the numbers of balsam fir and white pine show large deviations from expected values.

**Number of Trees on New England Forest Health Monitoring Plots,[1] by Major Species and Tree Class**

| Species | Seedlings-saplings | Mature trees Live | Mature trees Dead | All Classes |
|---|---|---|---|---|
| Balsam Fir | 3,378 | 646 | 228 | 4,252 |
| Red Spruce | 665 | 711 | 63 | 1,439 |
| E. White Pine | 218 | 716 | 71 | 1,005 |
| N. White-Cedar | 309 | 358 | 32 | 699 |
| E. Hemlock | 293 | 426 | 11 | 730 |
| Other conifers | 223 | 148 | 30 | 401 |
| **All conifers** | **5,086** | **3,005** | **435** | **8,526** |
| Red Maple | 1,618 | 1,031 | 49 | 2,698 |
| Sugar Maple | 1,543 | 487 | 29 | 2,059 |
| Yellow Birch | 388 | 272 | 34 | 694 |
| Paper Birch | 664 | 338 | 39 | 1,041 |
| American Beech | 505 | 264 | 21 | 790 |
| White Ash | 565 | 175 | 8 | 748 |
| N. Red Oak | 264 | 188 | 3 | 455 |
| Other hardwood | 2,650 | 721 | 117 | 3,488 |
| **All hardwood** | **8,197** | **3,476** | **300** | **11,973** |
| **All species** | **13,283** | **6,481** | **735** | **20,499** |

[1]Data from 204 forested FHM plots; major species determined by those with greater than 170 sample trees.

The less-than-expected number of balsam fir trees is probably a result of mortality caused by eastern spruce budworm and increased cutting in response to budworm infestation. White pine was sampled at greater-than-expected levels in both the white pine and northern hardwoods forest-type groups and at less than expected levels in spruce-fir and oak-hickory forest-type groups. While there is no full explanation for these results, gypsy moth defoliation of white pine and accelerated mortality of the species since the last extensive forest surveys must be considered as one possible cause.

The distribution of standing-dead trees by species is comparable between FHM and that expected from previous forest surveys. The distribution of trees by diameter class in the FHM sample differs significantly from that expected of earlier forest surveys for both conifer and hardwood species. The difference is found in an "undersample" of conifers 3.0 to 8.9 inches in diameter and an "oversample" of hardwood saplings.

# Tree Crown Ratings

Each sampled tree was rated for three (hardwood) or four (conifer) crown characteristics: crown dieback, foliage transparency and discoloration, and needle retention. The ratings are reported only for upper-canopy trees (trees with crowns directly exposed to the atmosphere) though the data were collected for all-live trees. Across all forested plots, upper-canopy trees account for 69 percent of all sampled trees 5.0-inches or larger in diameter.

## *Crown dieback*

Crown dieback is defined as branch mortality beginning at the tip of the branch and proceeding inward toward the trunk. This pattern of mortality is an indicator of premature branch death. Dead branches in the lower crown are assumed to have died of suppression or natural senescence due to tree growth and are not included in this measurement.

Ninety-six percent of all upper-canopy trees were tallied as having none-to-light crown dieback. Over all the plots, hardwood species generally had greater crown dieback than conifers. More than 13 percent of the American beech sample was recorded with greater than 20-percent crown dieback. Without further diagnosis, the cause of these symptoms cannot be specified, but the occurrence of the beech bark disease complex is a possible reason. The symptoms are compatible with this disease and the complex is well established in New England.

## Distribution of Open Grown, Dominant, and Codominant Trees on FHM Plots,[1] by Percent Crown Dieback Class for Major Species

| Species | None (0-5%) | Light (6-20%) | Moderate (21-50%) | Severe (51+%) |
|---|---|---|---|---|
| *Percent of sampled trees* | | | | |
| Balsam Fir | 91.4 | 7.2 | 1.1 | 0.3 |
| Red Spruce | 92.7 | 6.0 | 1.1 | 0.2 |
| E. White Pine | 92.4 | 6.6 | 0.8 | 0.2 |
| N. White-Cedar | 82.8 | 12.1 | 4.0 | 1.0 |
| E. Hemlock | 93.0 | 3.5 | 2.9 | 0.7 |
| Red Maple | 67.2 | 26.5 | 4.4 | 1.9 |
| Sugar Maple | 87.0 | 10.1 | 2.4 | 0.5 |
| Yellow Birch | 77.9 | 18.8 | 1.4 | 1.9 |
| Paper Birch | 68.6 | 27.0 | 3.1 | 1.4 |
| American Beech | 54.7 | 32.1 | 7.5 | 5.7 |
| White Ash | 71.3 | 25.0 | 1.5 | 2.2 |
| N. Red Oak | 50.0 | 49.4 | 0.0 | 0.6 |

The header "Percent Crown Dieback Class" spans the four rating columns.

[1]Data from 204 forested FHM plots

### *Foliage transparency*

Foliage transparency is defined as the amount of skylight
visible through the foliated portion of a tree crown and
accounts for foliage reductions due to insect damage,
pathogens, or environmental stress. The degree of foliage
transparency differs by species and depends on branching and
leafing patterns. Foliage transparency serves as an estimator
of defoliation.

Almost 96 percent of all exposed tree crowns were recorded
with "normal" foliage transparency levels. Of the major forest
species, severe foliage transparency symptoms (greater than
1 percent of the sample trees) were reported only for yellow
birch, American beech, and northern red oak.

**Distribution of Open Grown, Dominant, and Codominant Trees on FHM Plots,[1] by Percent Foliage Transparency Class for Major Species**

| Species | Foliage Transparency Class | | |
| --- | --- | --- | --- |
| | Normal (0-30%) | Moderate (31-50%) | Severe (51+%) |
| | *(Percent of sampled trees)* | | |
| Balsam Fir | 99.7 | 0.3 | 0.0 |
| Red Spruce | 99.8 | 0.2 | 0.0 |
| E. White Pine | 95.5 | 4.5 | 0.0 |
| N. White-Cedar | 91.9 | 7.6 | 0.5 |
| E. Hemlock | 97.9 | 2.1 | 0.0 |
| Red Maple | 95.6 | 3.5 | 0.9 |
| Sugar Maple | 98.9 | 0.8 | 0.3 |
| Yellow Birch | 96.2 | 1.9 | 1.9 |
| Paper Birch | 92.8 | 6.5 | 0.7 |
| American Beech | 86.8 | 6.9 | 6.3 |
| White Ash | 94.9 | 5.1 | 0.0 |
| N. Red Oak | 90.4 | 4.8 | 4.8 |

[1] Data from 204 forested FHM plots

At this time there is no record to determine "normal" levels of
foliage transparency for any species other than sugar maple.
This survey will develop the data to establish species-specific
foliage transparency standards from which to identify
abnormal conditions. Presently, we can examine those tree
records with high levels of foliage transparency (that is, thin
crowns) for other indications of health problems (for example,
other crown ratings, other signs and symptoms).

### *Foliage discoloration*

Foliage is considered discolored when the overall appearance is noticeably yellow, red, or brown. More than 50 percent of a leaf or needle must be discolored for discoloration to be tallied. The occurrence of trace amounts of discoloration is expected for any tree. Results from the 1990 field season provide no indication of health concerns expressed as early or abnormal discoloration.

### *Needle retention*

Needle retention is defined as the number of years needles are retained by a conifer and indicates tree vigor. Needle retention is measured as the year of oldest needle-year class with more than 25 percent of the needles present. The longer the tree retains needles, the more vigorous its growth is expected. The results of needle retention measurements provide no indication of forest health concerns.

## Signs and Symptoms

Signs and symptoms, indicative of previous injury, disease, or insects are recorded to provide an explanation of adverse growth effects or mortality. The occurrence of a sign or symptom was recorded only when significant and when likely to result in the eventual decline and death of the tree. A list of common signs and symptoms had been provided and their occurrence was recorded when observed. Results from 1990 suggest no unexplainable forest health concerns.

## Indicator Plants

Exposure to ozone, sulfur dioxide, and hydrogen fluoride, atmospheric gas pollutants, can cause recognizable foliar symptoms on certain plant species. These plants can serve as "bioindicators" of the pollutants. At, and adjacent to, each FHM plot, forest openings were searched for the presence of bioindicator plant species. Foliar symptoms were recorded when observed. The presence of one or more indicator plant species, for one or more of the air pollutants, was recorded on 192 locations. Ozone symptoms were recorded on 18 locations, sulfur dioxide symptoms on 6 locations, and no hydrogen fluoride symptoms were observed.

## Status of Major Forest Insects and Pathogens in New England in 1990

This summary reviews the major forest insect and pathogen problems and declines of 1990 in the New England states. The information was compiled from state pest condition reports and surveys of the USDA Forest Service, Northeastern Area State & Private Forestry, Forest Health Protection, Durham Field Office.

The major hardwood pests are defoliators. The New England oak — and at times white pine and hemlock — resource is still affected by extensive gypsy moth defoliation. In 1990, over 700,000 acres of defoliation were reported in the New England. Defoliation increased over the previous year's level, particularly in Maine, Vermont, New Hampshire, Massachusetts, and Connecticut. In many areas significant larval mortality occurred due to fungal infection; however, populations remain high or continue to expand in these states. Very low populations and no significant defoliation have been reported from Rhode Island in the last 2 years.

Other hardwood defoliators such as the eastern tent caterpillar, forest tent caterpillar, and the oak leaf tier were at low levels in most of the region. The incidence of pear thrips also was at a lower level than in recent years in most areas, however the insect caused increased damage in Vermont. Populations of the saddled prominent increased in Vermont and Massachusetts and caused defoliation in scattered locations.

The major conifer pests include defoliators and stem and twig insects. Spruce budworm populations continue at very low levels in northern New England. The hemlock looper infestation in Maine is expanding, and the insect caused localized defoliation in Vermont. Damage from the hemlock woolly adelgid and red pine adelgid was noted in Connecticut and Rhode Island. These insects are expanding into Massachusetts and the hemlock woolly adelgid was found at one site in Vermont. The spruce beetle is causing mortality of larger spruce in northern Maine, and the area of infestation is increasing in size and intensity. This insect also is causing spruce mortality at other sites in northern New England. The balsam woolly adelgid is causing damage to balsam fir crowns at scattered sites in northern New England.

One of the more significant diseases in the region is beech bark disease. Damage from the disease can be found throughout the region, but the amount of tree crown dieback and mortality varies. *Cytospora* canker on spruce and diplodia tip blight on pine has caused damage in several localized areas. European larch canker and scleroderris canker are still under quarantine in several states, however the incidence of these diseases is currently static. Several foliar diseases were reported this year. The most significant was anthracnose, which caused damage on maple and other hardwoods in Vermont, Massachusetts, and Rhode Island. Dutch elm disease is

common throughout the region, as a new, more virulent strain is spreading. Reports of localized drought effects and winter injury on conifers were reported in some of the states. In Maine a disease known as Stillwell's syndrome, associated with Armillaria root disease, continues to cause low levels of mortality in balsam fir stands over an extensive area previously defoliated by the spruce budworm.

Several diebacks on various species were reported. Ash dieback, commonly associated with ash yellows, caused mortality in Maine, Vermont, and Massachusetts. Larch mortality, usually in association with the eastern larch beetle is occurring in Vermont and Maine. Birch dieback is reported from Vermont and especially Maine, where several areas in the western and eastern parts of the state are affected. Dieback of maple is reported throughout the region, but in most cases less than 10 percent of the crown is affected and losses are insignificant. Spruce dieback continues to be reported, with the problem most noticeable at the higher elevations.

## Summary

The objectives of the 1990 FHM field season were the establishment of the permanent plot network and the collection of 1$^{st}$ year crown rating and growth data. The FHM plot sample corresponds very closely to New England forest resource characteristics as reported by previous forest surveys. The distribution of locations and tree species are not significantly different from expectations. Such deviations between samples as were found can be explained from known changes since the last extensive survey in the New England forest.

The summary of crown ratings data from open grown, dominant, and codominant trees indicates no pattern of major decline in any species. For many species, these data represent the first such measurement and an exact interpretation is difficult. The full value of the data, as well as diameter measurements, will be realized with plot remeasurements in succeeding years. This year's data will establish the baseline against which to identify changes in subsequent years.

6/27/91